From the sea to the stars: The NEEMO Project

Barracudas, their prehistoric, menacing teeth glinting in the Atlantic-filtered sunlight, circle beneath a 40-foot-wide yellow life-support buoy. Above them, four divers don their wet suits and air tanks on the deck of a small boat bobbing in the waves off the coast of Key Largo, Fla. The divers splash into the water one by one, then begin a descent of about 60 feet to their home for the next week – the undersea laboratory known as Aquarius.

The divers are not oceanographers but rather Johnson Space Center members of the NASA Extreme Environment Mission Operations (NEEMO) team. They are about to become "aquanauts" and use the laboratory owned by NASA's sister agency, the National Oceanographic and Atmospheric Administration, to simulate life on the International Space Station.

"Living underwater is the closest parallel to living in space in that they are both extreme environments," said NEEMO Project Lead Bill Todd.

Todd is a United Space Alliance space shuttle simulation supervisor veteran of 17 years and a member of the first NEEMO aquanaut crew in 2001. He believes strongly in the potential benefits of the project.

"The time frame for missions involves long periods of time away from normal environments and families," he said. "Communication with others is not always immediate. Because of the fact that in both environments one cannot readily come home, repairs or replacements must be able to be made on the spot, if necessary."

NASA JSC 200236934

A NEEMO mission takes lots of teamwork. The team pictured here is (L-R): Astronaut Scott Kelly, Space Station Support Scientist Jessica Meir, instructor Paul Masaki, Flight Director Paul Hill, Astronaut Rex J. Walheim and instructor Mark Hulsbeck. Kelly, Meir, Hill and Walheim were the crewmembers of NEEMO 4.

The NEEMO missions are a cooperative project of NASA, NOAA, the National Undersea Research Center (NURC) and the University of North Carolina at Wilmington (UNCW). The missions utilize Aquarius, the only undersea research laboratory in the world, which is owned by NOAA and managed by UNCW.

The 45-foot-long, 13-foot-diameter laboratory is situated next to deep coral reefs about three miles off Key Largo in the Florida Keys National Marine Sanctuary. Aquarius provides life support systems that allow scientists to live and work in reasonably comfortable quarters.

'It was a real mission'

Although the aquanauts are only 60 feet underwater, that depth effectively isolates them from the surface. After their mission, Aquarius residents must undergo a deliberate 15-hour decompression process in which their bodies reacclimate to the lower atmospheric pressure on the surface. Without this readjustment period, nitrogen bubbles from their bloodstream could collect in their joints and cause a very painful and life-threatening condition known as "the bends."

This degree of isolation makes NEEMO training different from other types of training available at JSC.

"Aquarius wasn't a simulation," said Astronaut Scott Kelly, who commanded the last NEEMO mission of 2002, and who also piloted STS-103 in 1999. "It was a real mission designed to train us for certain aspects of spaceflight with an extra element of realism you would never get in a simulation. There were real risks involved."

Living arrangements add another degree of realism to a NEEMO mission. "Living in very confined quarters adds dynamics between individuals and makes it similar to spaceflight," Kelly said. "The best part is the people you work with; the worst part is being away from your home and family – just like flying in space."

The training provided by a NEEMO mission can be so beneficial to astronauts that NEEMO may soon be considered "graduate-level" training and leadership experience for first-time astronauts and commanders.

Support from the ground

Four separate crews of aquanauts made their way to Aquarius this year and last year for a combined total of 29 days of life and work inside and outside the undersea lab. As with spaceflight missions, the crews required support from a team on solid ground.

A small core NASA surface support team – Project Lead Todd, Mission Leads Monika Schultz and Marc Reagan, Operations Planner Michelle Lucas and Medical Officer Dan Fitzpatrick – worked out of a NURC-provided condo on the Key Largo marina. The condo provided bunk space for crews and support team members and was next door to the research center's logistics and communications facility – essentially its Mission Control.

To speak with crews in Aquarius, support team members would go next door and use "undersea to ground" communications loops and wireless data channels similar to those that connect Mission Control to the space shuttle and station. Additional support teams from the Astronaut Office and Space and Life Sciences Directorate gave support as needed.

Similarities to space missions spill into scientific research and educational outreach. NASA's NEEMO crewmembers conducted human physiology research, remote medicine, and human factors and habitability studies and worked with oceanographic researchers to collect data on the state of coral reefs in the area.

They also practiced space-walking techniques using tools and tethers similar to those used on orbit. And they helped reach out to students through interactive distance learning events, cooperative efforts of JSC's Distance Learning Outpost and NASA Ames Research Center's Quest Web project. Aquanauts even answered news reporters' questions as an analog to interviews and news conferences routinely conducted on spaceflights.

Future missions in the planning stage also are expected to expand participation of JSC's Exploration Planning and Operations Center control room, simulating the interactions between astronauts and control rooms.

"We've learned in the past year what we really can get out of this facility," said Schultz, who is the expeditionary training manager in the Astronaut Office, "and we've learned it really is the best analog for a true mission." ❖

To learn more about NEEMO and view the NEEMO 4 Distance Learning Outpost event, visit http://quest.arc.nasa.gov/projects/space/aquarius/2002/index.html.

NASA JSC 200236931

A sea turtle explores the sea floor near the Aquarius Underwater Research Facility off the coast of Key Largo, Fla.

The NEEMO Missions

NEEMO 1
When: Six days, October 2001
Who: Project Lead Bill Todd and Astronauts Mike Lopez-Alegria, Mike Gernhardt and Dave Williams

NEEMO 2
When: Nine days, May 2002
Who: Astronauts Mike Fincke, Dan Tani and Suni Williams, and NASA Station Training Lead and Surface Support Team Lead Marc Reagan

NEEMO 3
When: Nine days, July 2002
Who: Astronauts Jeff Williams, Danny Olivas and Greg Chamitoff, and Human Systems Engineer Jonathon Dory

NEEMO 4
When: Five days, September 2002
Who: Astronauts Rex Walheim and Scott Kelly, Space Station Support Scientist Jessica Meir and NASA Flight Director Paul Hill

NASA JSC 200236932

Background image: Astronaut Rex Walheim (right) and Space Station Support Scientist Jessica Meir (center) follow the lead of an instructor as they team to inflate a surface signal device during an underwater exercise.